CHAPTER 1

INTRODUCTION

1-1. Purpose. This manual provides guidelines for the engineering analysis of coastal water levels and waves. The guidance is primarily for the planning and preliminary design states of a project. The design engineer is expected to adapt the general guidance presented in this manual to site-specific projects. Deviations from this guidance are acceptable if adequately substantiated.

1-2. Applicability. This manual is applicable to all HQUSACE elements and field operating activities responsible for the planning, design, construction, and operation and maintenance of civil works projects.

1-3. References. The references listed below are needed to implement some of the guidance in this manual.

a. EM 1110-2-1412, Storm Surge Analysis and Design Water Level Determinations.

b. Harris, D. L. 1981 (Feb). "Tides and Tidal Datums in the United States," Special Report No. 7 (SR-7). Available from Library, US Army Engineer Waterways Experiment Station, Vicksburg, MS 39180-0631.

c. National Oceanic and Atmospheric Administration, "Tide Tables, High and Low Water Predictions, East Coast of North and South America Including Greenland." Available from National Ocean Service, Rockville, MD 20852 (published annually).

d. National Oceanic and Atmospheric Administration, "Tide Tables, High and Low Water Predictions, West Coast of North and South America Including the Hawaiian Islands." Available from National Ocean Service, Rockville, MD 20852 (published annually).

e. Shore Protection Manual (SPM). 1984. 4th ed., 2 Vols, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. Available from Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

1-4. Bibliography. Bibliographic items are cited in the text by numbers (items 1, 2, etc.) that correspond to items in Appendix A. Where any reference or bibliographic item contains information that conflicts with this manual, the provisions of this manual shall govern.

1-5. Background and Scope. Virtually every coastal and harbor project requires information about local water levels and wave heights. This manual is concerned with procedures for obtaining, interpreting, and applying water level and wave information. The manual addresses projects located in the coastal zone and subject to attack by waves and currents of the oceans, bays, and Great Lakes. Specific types of projects include shallow and deep draft coastal navigation; shore and beach restoration, protection, and nourishment; and coastal wave and flood protection projects.

1-6. Discussion.

a. Critical Conditions. In the selection of design water levels and design waves for a project, the critical conditions must be considered. The conditions represent critical threshold combinations of tide level, surge level, wave conditions, etc., which, if surpassed, will endanger the project and/or make the project nonfunctional during their occurrence.

(1) Water levels and waves cannot generally be considered independent of each other in determining critical conditions. Water levels have a direct impact on wave conditions in shallow water, particularly when the waves are near the point of depth-limited breaking. Also, waves can have some impact on water level, especially in the surf zone where wave-induced setup can raise the local water level by significant amounts.

(2) Three types of considerations relate to the design of a project. The first (structural integrity) relates to the structure's ability to withstand the effects of extreme storms without itself suffering significant damages. The second (functional performance) deals with the effectiveness of the structure at its intended function. The third (constructibility) relates to means, methods, materials, etc. involved in project construction.

(3) Structural integrity criteria determine the structure's life-cycle costs to the extent that a certain level of investment is necessary to prevent damages from an extreme event. There will always be a finite probability that any storm, no matter how extreme, will be exceeded in intensity; so this consideration also determines the expected repair costs during the project life. The most extreme sea state in which a particular structure design will suffer no damages cannot in practice be precisely defined. The statement of structural integrity should be phrased with this in mind. It should be stated in terms of the desired effect, such as prevention of breakwater damages (and associated repair costs). An example would be "damages to more than 5 percent of the breakwater armor will occur with less than 2 percent probability per year." There are numerous complications in achieving such a goal, including definition of the types of possible damages and determining the combined probability per year of the physical parameters (wave height, wave period, wave direction, water level, storm duration, and others) which could cause them. Nevertheless, this is a workable statement in terms of an objective, adaptable to more than one means of determining structural dimensions.

(4) Functional performance determines the incremental economic benefits of a project since it defines the structure's level of effectiveness. It also affects the cost since a certain additional increment of investment may be necessary to achieve a given level of effectiveness. For a breakwater, this level of effectiveness can usually be stated in terms of a maximum transmitted wave condition during a given extreme event. The probability of exceedance for this event can in turn be related to property damage and other economic losses. A workable statement of functional performance might be that 10 percent of transmitted waves can be related to some level of unacceptable property damage or operational disruption landward of the breakwater. An even more general statement might be that navigational delays and property damages from transmitted waves shall occur with less than 5 percent probability per year.

(5) Constructibility includes consideration of project construction requirements. The considerations may include requirements for low water access by land equipment, high water access by floating equipment, curing of cast-in-place concrete, etc.

b. Estimation of Water Levels and Waves. Probabilities of exceedance of critical conditions for structural integrity, functional performance, and constructibility design conditions are estimated using the information in this manual as shown by the flow diagram in Figure 1-1. Some branches of the flow diagram are inapplicable to certain design problems. For example, tsunamis are generally an important design consideration only in and around the Pacific Ocean basin.

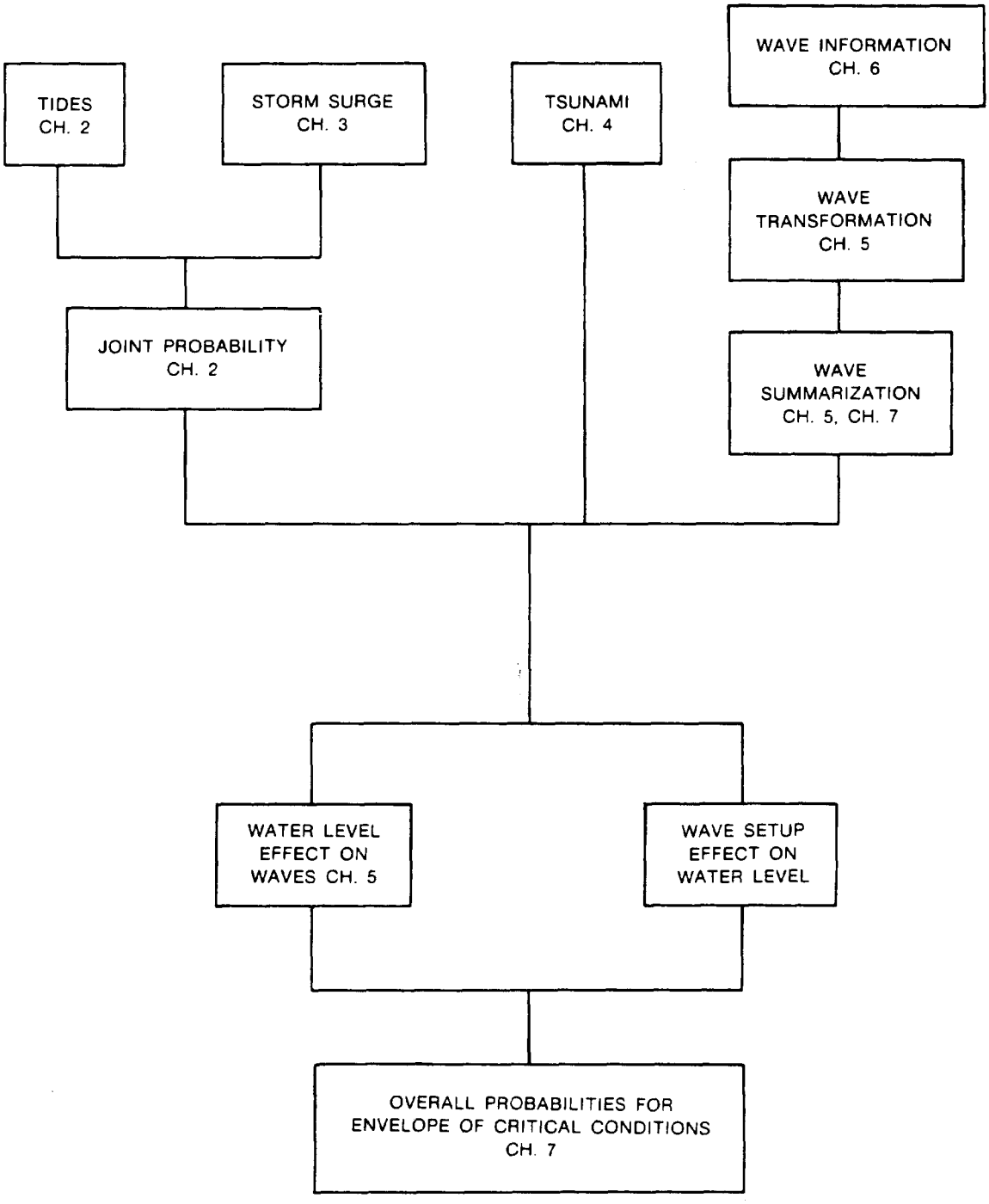

Figure 1-1. Flow diagram for the use of this manual